Geosynchronous Microwave (GEM) Sounder/Imager: A GPM Interpolator

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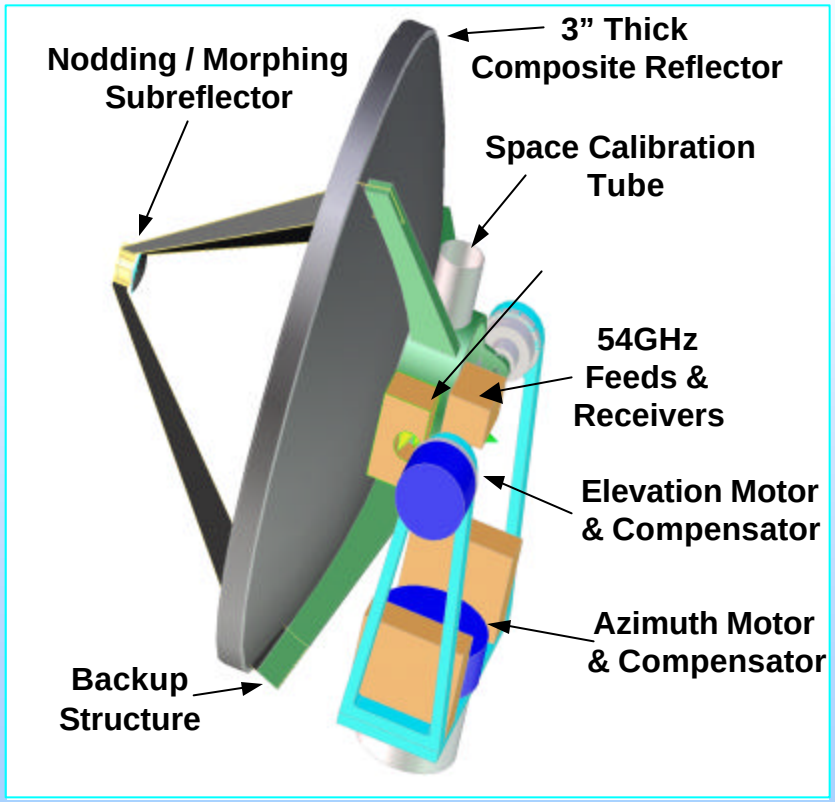
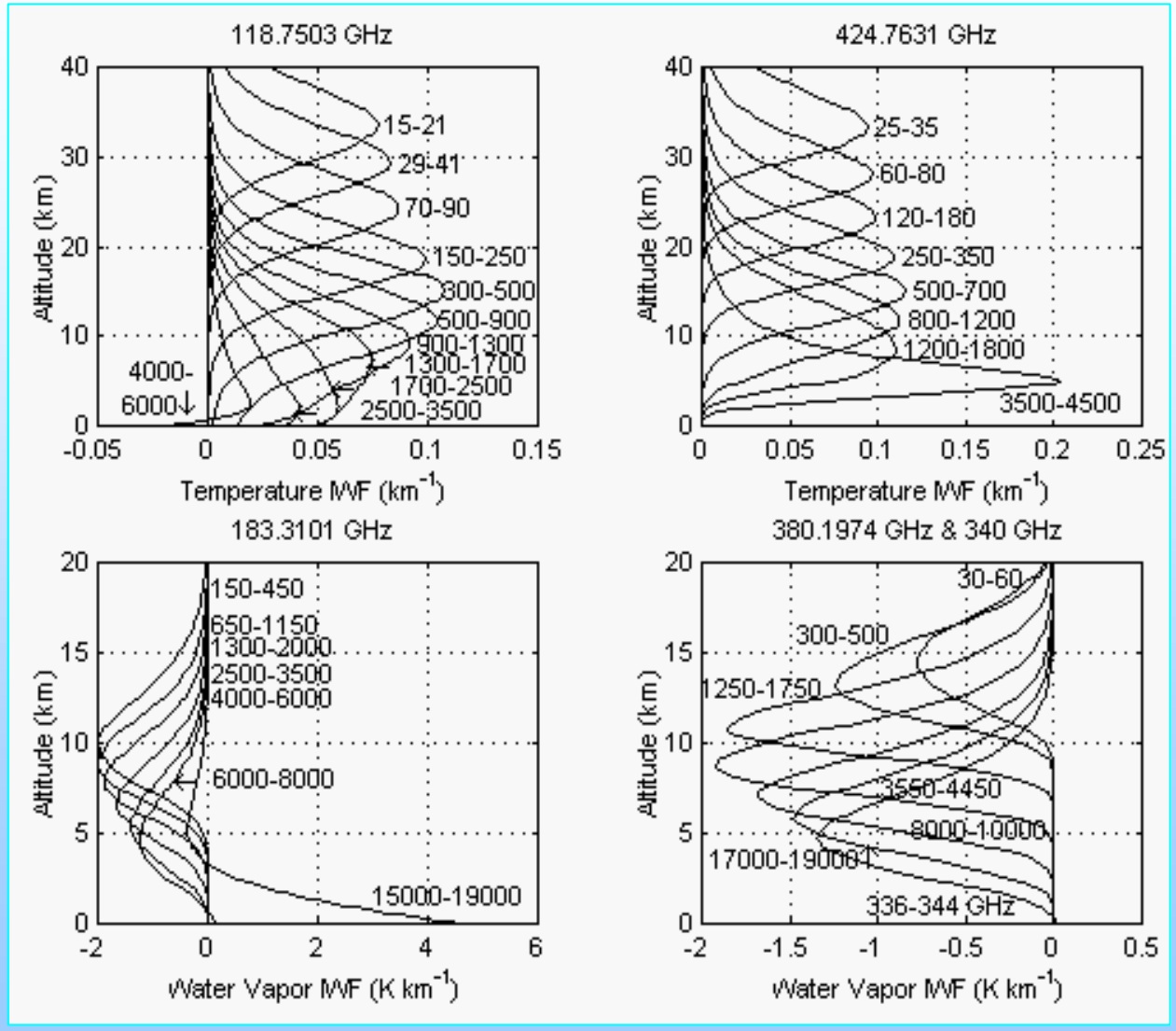
GMSWG* Concept Summary

- **Baseline system using 54, 118, 183, 380, and 424 GHz with 2-meter aperture.**
- **~20 km equatorial resolution (15 km using oversampling) above 2-5 km altitude at highest frequency channels.**
- **The 380 and 424 GHz channels can map precipitation through most optically opaque clouds at sub-hourly intervals.**
- **Temperature and humidity sounding channels penetrate clouds sufficiently to drive NWP models with hourly data.**
- **Estimated costs: $29M non-recurring plus ~$26M per unit.**



* Geosynchronous Microwave Sounder Working Group, Chair: D.H. Staelin (MIT Lincoln Laboratory)

GEM Vertical Response



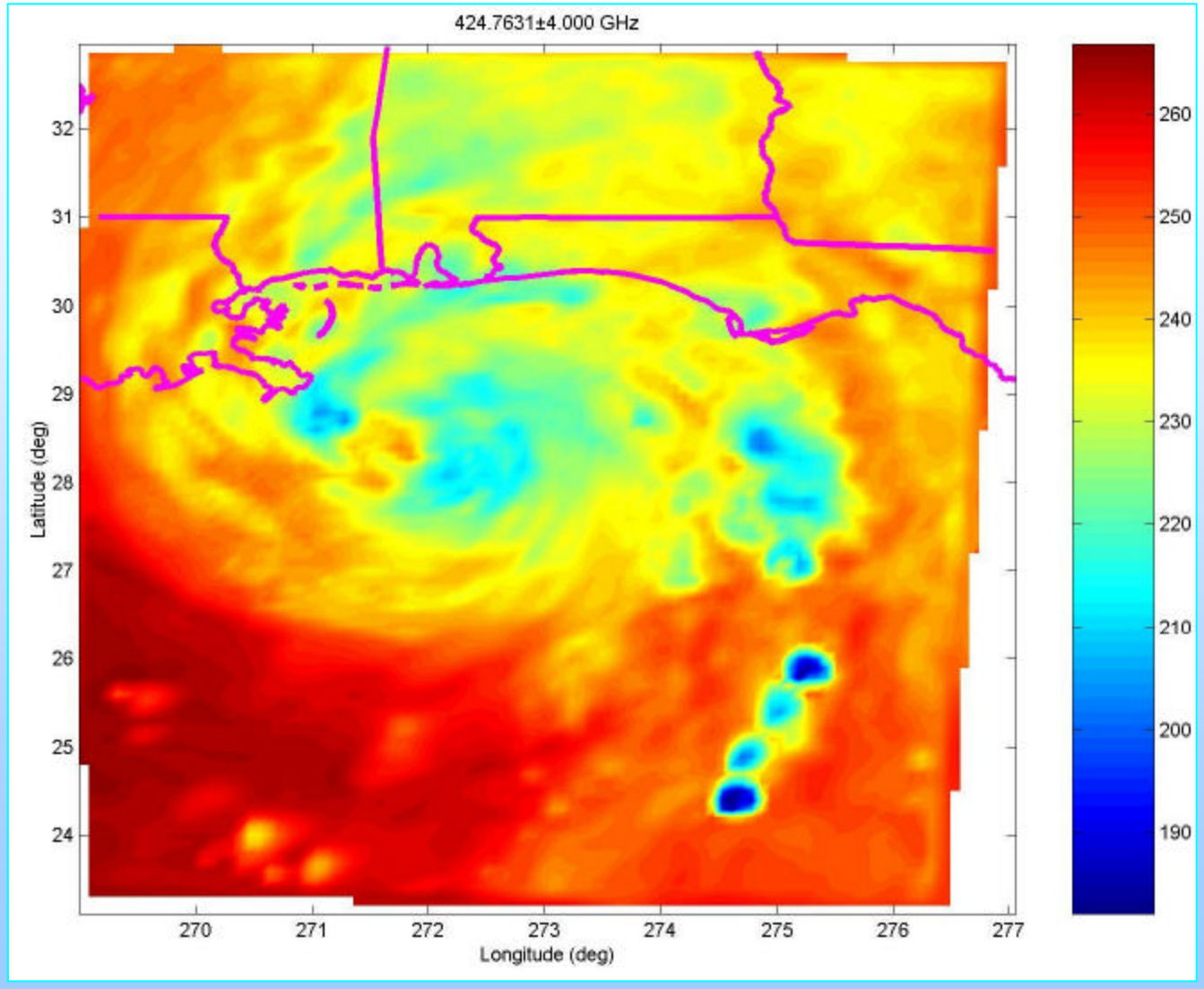
Clear-air incemental weighting functions

O_2
118.750 GHz
424.763 GHz

H_2O
183.310 GHz
380.197/340

Klein & Gasiewski, JGR-ATM, July 2000.

GEM Simulated Imagery

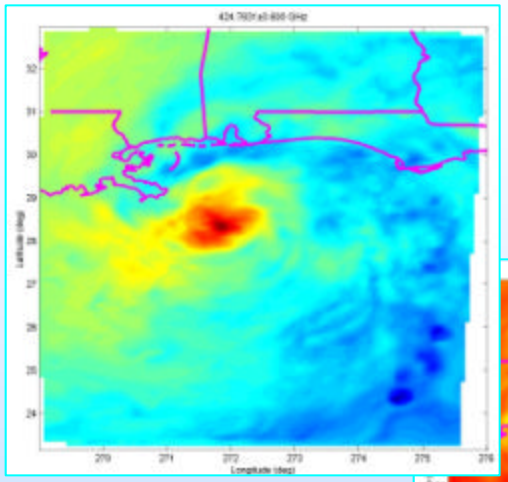


MM5/Reisner 5-phase simulation of Hurricane Opal, 1995

Nested 5-km inner grid with MRT scattering-based RT model

424.763+/-4.0 GHz channel

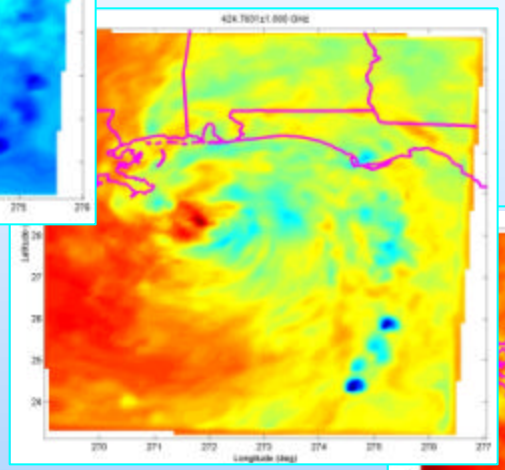
GEM Simulated Imagery



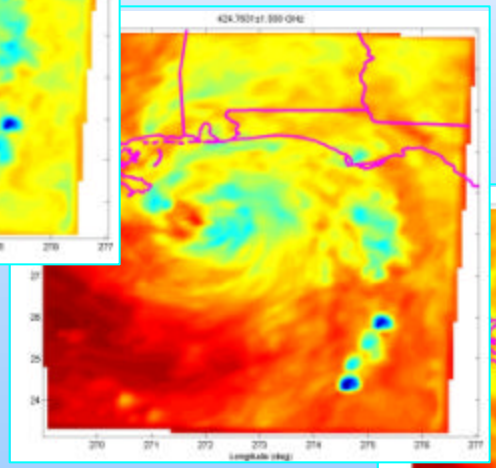
Opaque

Hurricane Opal
1995

+/-0.6 GHz

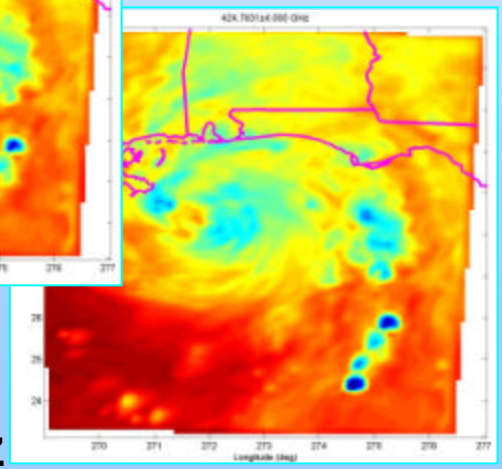


+/-1.0 GHz



+/-1.5 GHz

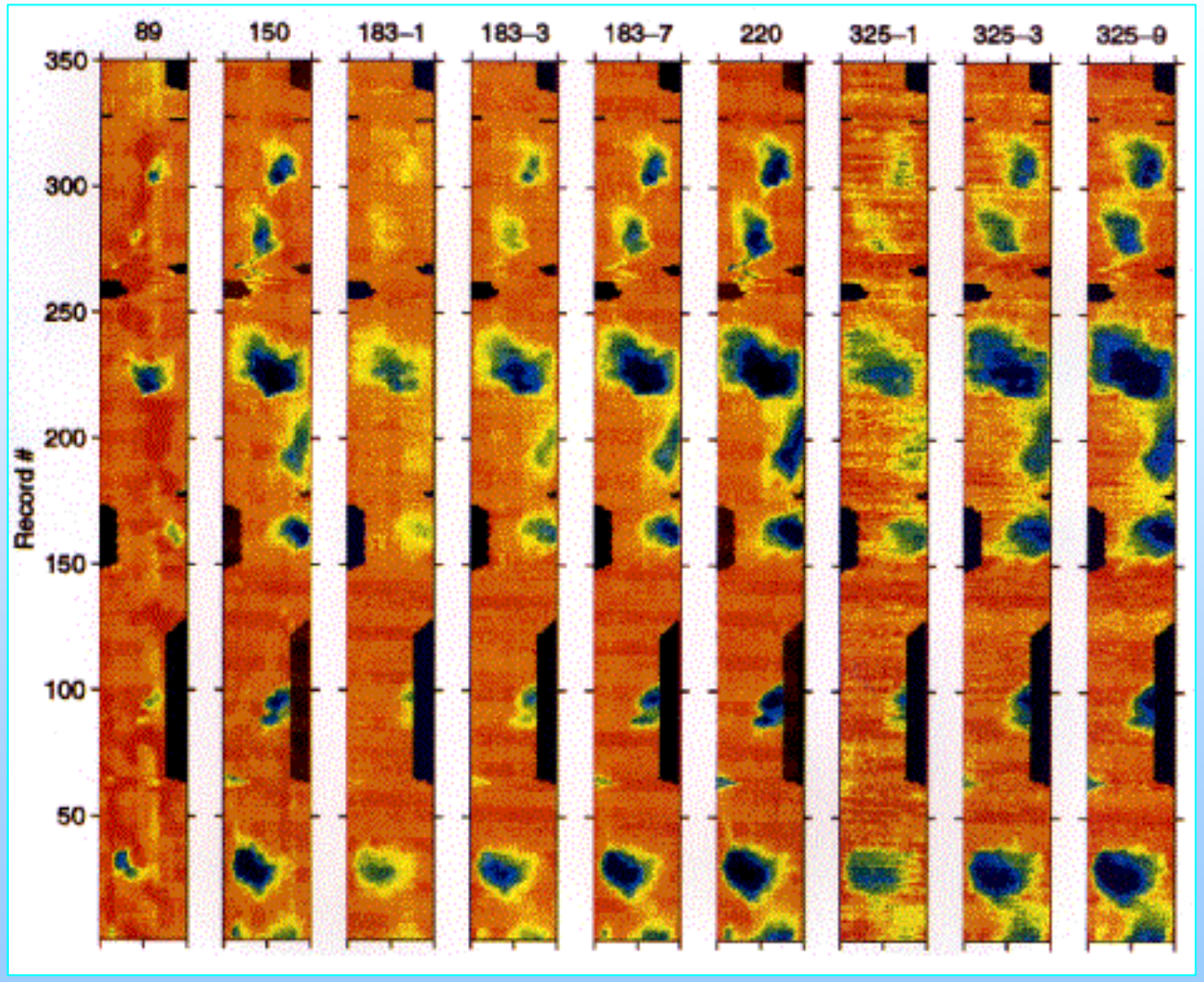
Transparent



MM5/MRT
Reisner 5-phase

424.763+/-4.0 GHz

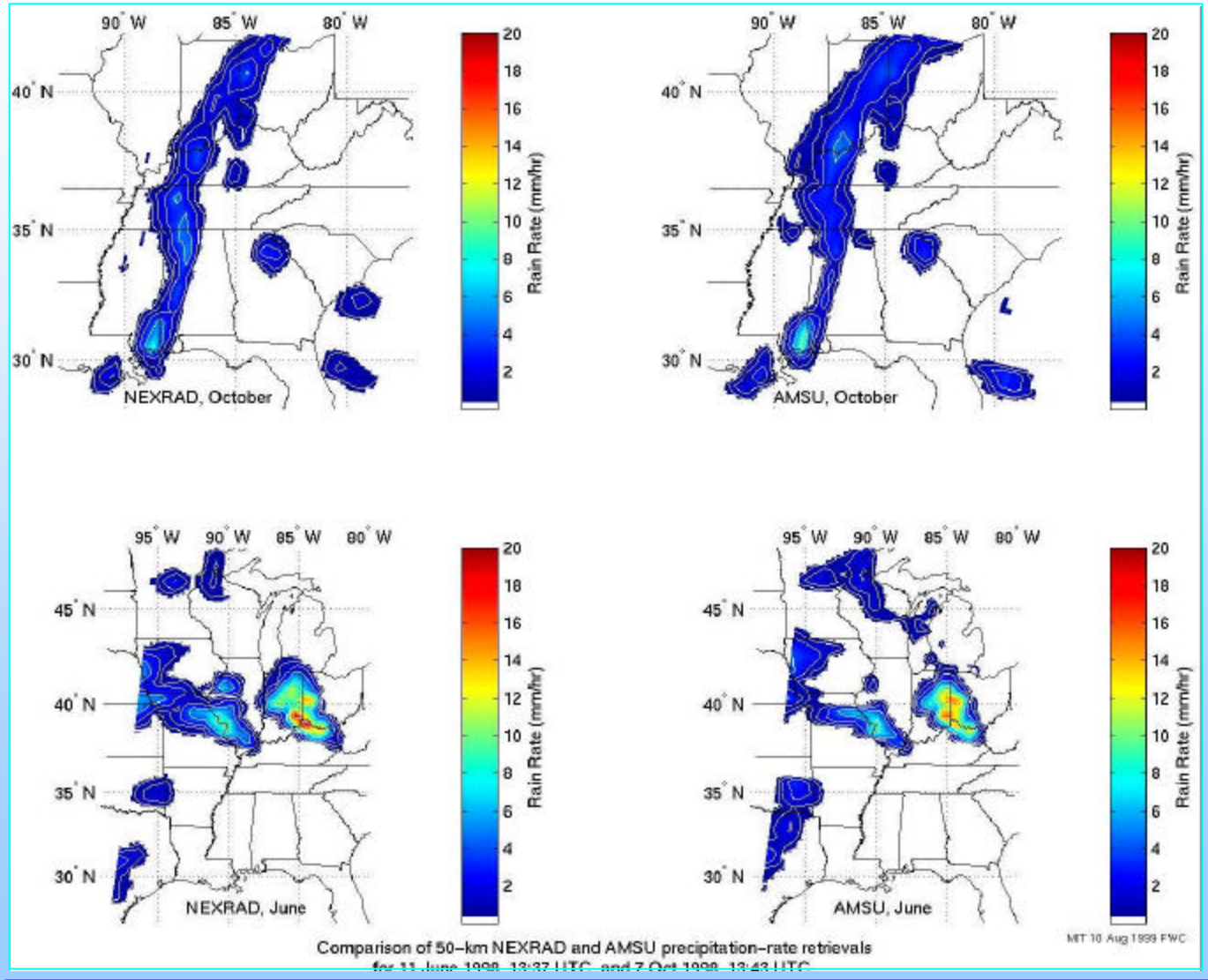
SMMW Aircraft Imagery



Maritime convection observed using MIR on ER-2 at 20 km altitude. Strip map dimensions: ~40x200 km

Many cells missed at 89 GHz!

Opaque-Channel Retrievals

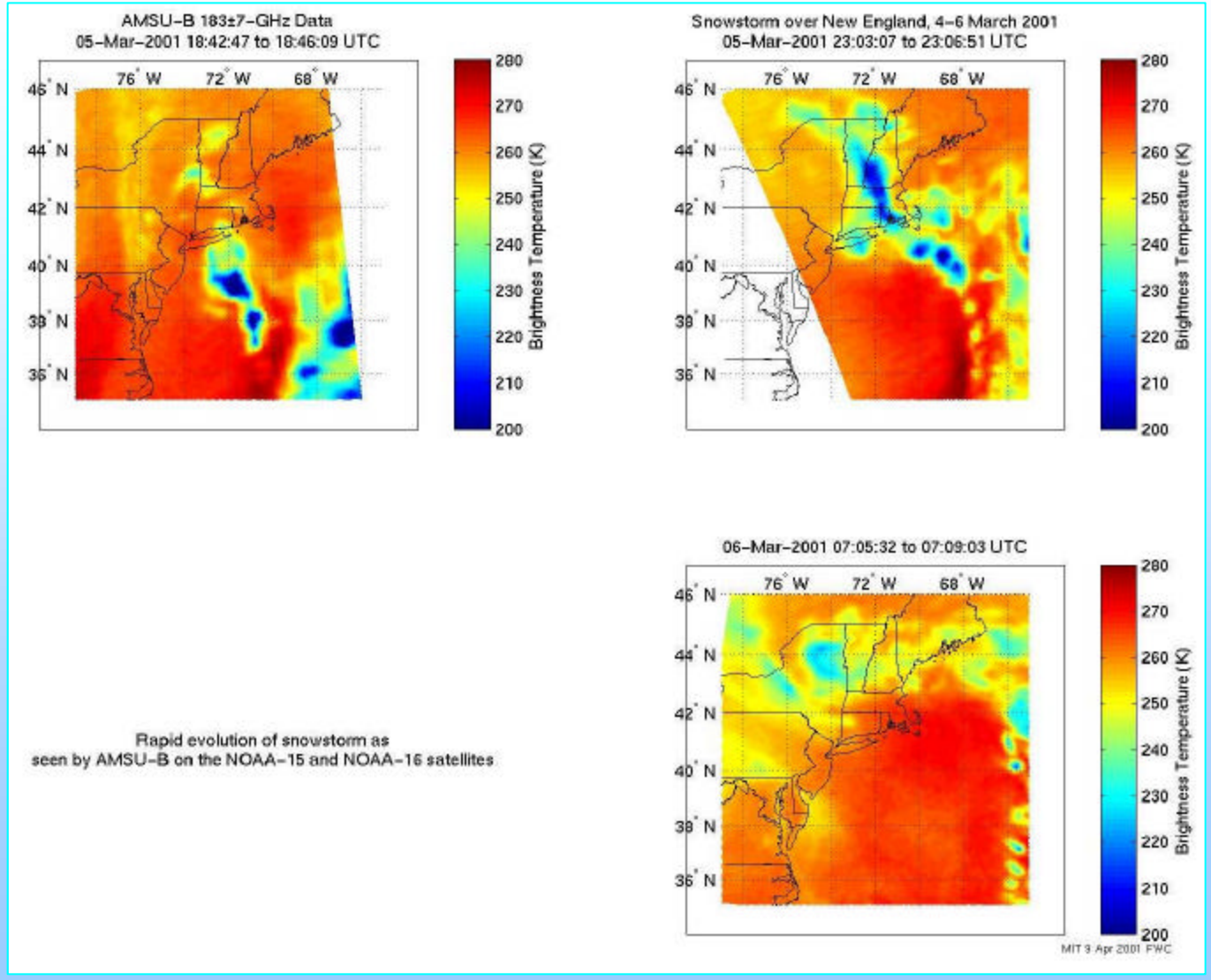


Comparison of 50–km NEXRAD and AMSU precipitation–rate retrievals

NOAA-15 AMSU with neural net retrieval, 50 km resolution

Staelin & Chen, *IEEE TGARS,* September 2000.

Rapid Precipitation Evolution



Rapid evolution of snowstorm as seen by AMSU-B on the NOAA-15 and NOAA-16 satellites

March 5-6 2001 snowstorm observed using AMSU-B

4 and 8 hr time gaps

Major evolution can occur on short time scales!

GEM Cost/Benefit for GPM

#Additional Drones	Repeat Time	Cost ($M)	
1	2.4 (hrs)	40	
2	2.0	80	Single HS cost break-point
3	1.7	120	
4	1.5	160	
5	1.3	200	
6	1.2	240	Global cost break-point
7	1.1	280	
8	1.0	320	
9	55 (mins)	360	
10	51	400	
15	38	600	
20	30	800	
25	25	1000	
30	21	1200	
35	18	1400	
40	16	1600	

Assumptions:

GEM cost of $30M + $60M bus & launch = $90M
TMI-class drone cost of $10M + $30M bus+launch = $40M
3 NPOESS + GPM PR provided as GPM baseline system
3 GEMs required for global tropical/midlatitude coverage

GEM for GPM - Summary

- GEM can be used as a cost-effective AMSU-class interpolator for GPM to obtain time-resolved observations of precipitation
- Strength of convection anticipated to be measurable over both land and water.
- GEM concept study completed, antenna and scanning technology under development (MIT/LL)
- Aircraft demonstration under development (NOAA/ETL)
- Demonstration of operational system possible within GPM timeframe. NMP 2007???

NOAA Research Interests for GPM

- GEM design and retrieval algorithm development
  (ETL, MIT, MIT/LL, NASA/LaRC)
- GPM passive microwave aircraft simulation
  (Polarimetric Scanning Radiometer – various A/C)
- GPM validation and ground radar-based studies
  (ETL, AL, NSSL, AOML)
- Application of GPM to Pacific coast precipitation
  forecasting & climatology (ETL PacJet Experiment)
- Passive microwave radiance assimilation (ETL, FSL,
  NCEP, NASA-NOAA JCSDA, NGDC)
- NOAA Climate Services Initiative (NOAA Research)

(see posters…)